Age and growth of *Capoeta erhani* Turan, Kottelat and Ekmekçi, 2008 from the Seyhan River (Southeast of Turkey)

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Abstract

Capoeta erhani is an endemic species to Southeast of Turkey. To date the information on biology of this species from inland waters of Turkey is very limited. The present study aims to provide the basic age and growth parameters of *C. erhani* from the middle basin of the Seyhan River. In total, 255 individuals were collected seasonally between October 2013 and September 2014. The overall sex ratio was 3.47:1 M : F. The total length of the specimens ranged from 10.4 to 33.0 cm and the weight from 9.0 to 360.0 g. The ages of total examined fish ranged from 0 to 5 years. Maximum age was found to be 5 years for both sexes. Length-weight relationship was described as logW= -5.067 + 3.168 logTL (r^2= 0.972). The von Bertalanffy growth parameters were: L_∞ = 32.51 cm; k = 0.400 $year^{-1}$; t_0 =-0.930 year for the entire population. Munro's phi prime index in males, females and both sexes was calculated as 6.00, 6.12 and 6.04.

Keywords: *Capoeta erhani*, Endemic species, Growth parameters, Fisheries

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Introduction

Age and growth studies are important in furthering understanding of life-history strategies of fish species (Sequeira *et al*., 2003). Analysis of age and growth of fish, indeed, can provide important insights into the ecology of a species and the assessment of its populations (Froese, 2006). Age determination of fish, therefore, is essential for decision-making in fisheries management (Weatherley and Gill, 1987). Also, they can contribute to stock identification based on between-regions comparisons of life histories traits of different populations (Moutopoulos and Stergiou, 2002).

Ceyhan scraper, *Capoeta erhani* Turan, Kottelat and Ekmekçi (2008) is an endemic Cyprinids species to Southeast of Turkey (Freyhof, 2014). The genus *Capoeta* is distributed in southern China, northern India, Turkmenistan, the Middle East, and Turkey (Turkmen *et al*., 2002; Ayyıldız *et al*., 2014). *C. erhani* was described for the first time from the Ceyhan River, Turkey (Turan *et al*., 2008) and then reported in Seyhan Dam Lake by Erguden Alagoz and Goksu (2012). The species inhabits many different lowland habitats as rivers and small lowland streams and it is also well adapted to reservoirs (Freyhof, 2014). The species is currently listed as least concern in the IUCN red list of threatened species (Freyhof, 2014), but the information on biology and ecology of this species is very scarce (Erguden Alagoz and Goksu, 2012; Ayyıldız *et al*., 2014; Erguden, 2015) and no estimates on length-weight relationships for this species are currently available on FishBase (Froese and Pauly, 2015). In Ceyhan drainage, especially the lower parts where the species is present, several large reservoirs were constructed for different purposes. As this species can well adapt to inhabit reservoirs, it is believed that its population trend could be stable. However, there are no data available on the population trends of this species (Freyhof, 2014) although *C. erhani* has a considerable economic importance for commercial fishing being fished and consumed within its distribution range.

The aims of this paper are to provide the first baseline data on the population biology of *C. erhani* in the Seyhan River of Turkey and to compare the results with those reported from different environments.

Materials and methods

Specimens of *C. erhani* were collected from the middle basin of Seyhan River that is the second largest river basin in the eastern Mediterranean Sea and an important area in terms of biodiversity richness. The samples of *C. erhani* were collected seasonally between October 2013 and September 2014 from 15 different stations located throughout the river in order to obtain a representative sample of the whole population (Fig. 1).

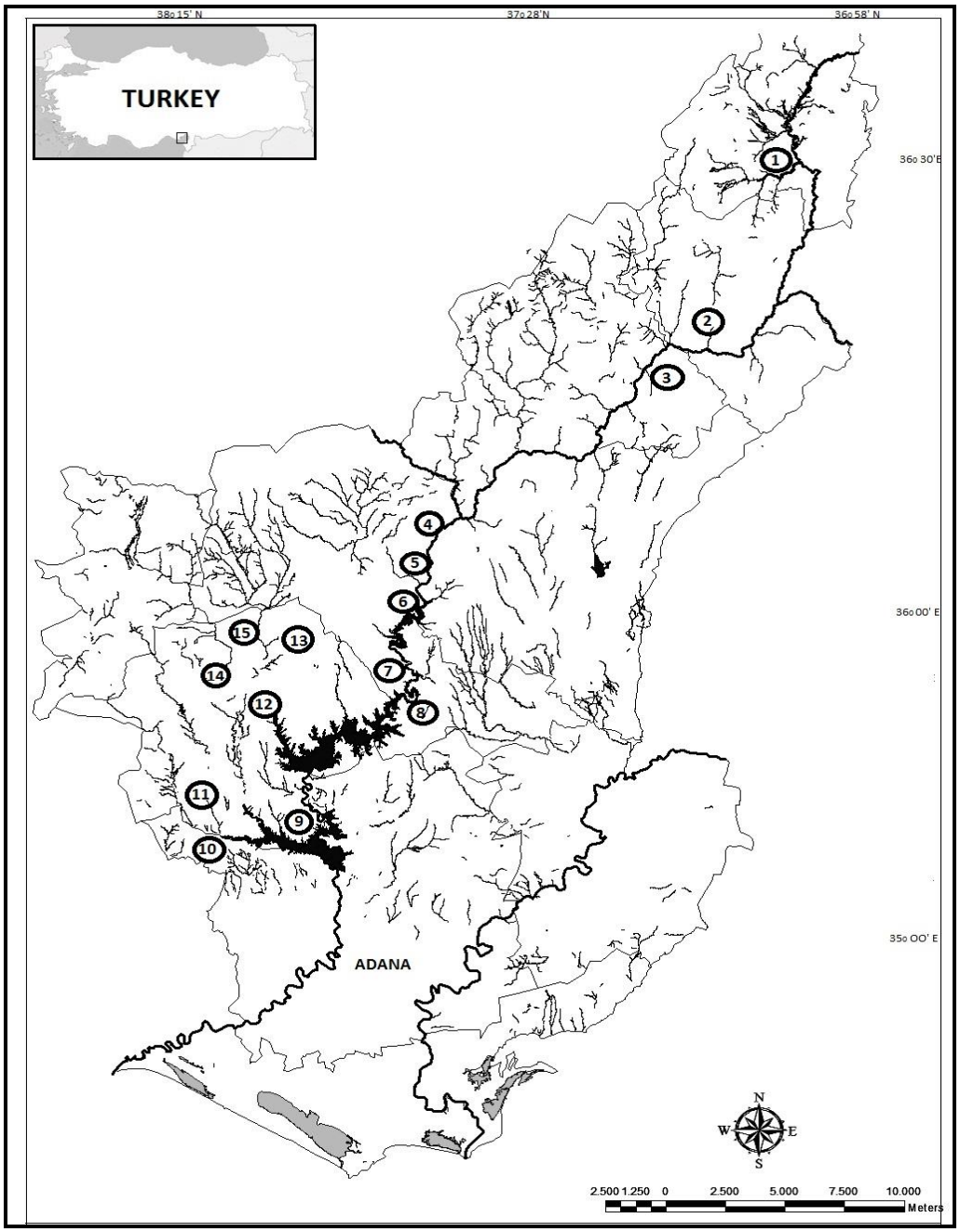

Figure 1: The map of Seyhan River and sampling stations; 1. Tufanbeyli-Adana, 2. Saimbeyli-Adana, 3. Himmetli-Adana, 4. Feke upper basin, 5. Feke-Adana, 6. Aladag (Dogan)-Adana, 7. Eyner village, 8. Sayca-Adana, 9. Kırıklı-Adana, 10. Salbaş-Adana, 11. Karaisalı (Ucurge village)-Adana, 12. Çorlu village-Adana, 13. Körkün-Adana, 14. Pozantı- Gökbez village, 15. Kamışlı-Hamidiye village (Menemenci bridge)-Adana.

Specimens were captured by gill nets or trammel net (22 mm to 35 mm cod-end mesh size) and transported to the research laboratory in polythene bags containing ice blocks to prevent spoilage and then stored in a deep freezer (-30°C) to avert deterioration. Samples were then measured for total weight (W), total length (TL) with sensitivity of 0.01g and 0.1mm, respectively. Sex was determined by microscopic observation of the gonads.

Differences in length between females and males within the same age groups were tested by Student's *t*-test ($p<0.05$).

Log transformed length-weight relationships were calculated for the total sample and separately for sex following Ricker (1975) as: log W = log a + blog TL where W is the total weight (g), TL the total length (cm), a is the intercept on the Y-axis of the regression curve and b is the slope (relative growth rate). Student's t-test was applied to test significant differences between the isometric growth (b=3) and the estimated b value of the equation (Zar, 1999).

Scales were used for age determination. Samples of scales were removed from the lateral side of the each fish, above the lateral line, near the dorsal fin (Baglinière and Le Louarn, 1987). Age readings were performed according to Chuqunova (1959) and Lagler (1966). Scales were read under a binocular microscope, scale reading being done twice by two independent readers.

The non-linear least squares regression was used to estimate the growth parameters of the von Bertalanffy (1938) growth equation, $L_t = L_\infty (1^{-e-k(t-t_0)})$ where L_t; is the total length at age t, L_∞; is asymptotic length, k; is the body growth coefficient and t_0; is theoretical age at zero length (Beverton and Holt, 1959).

The growth performance index (phi-prime index) φ' was computed from the equation $\varphi' = \ln k + 2x \ln L_\infty$ (Pauly and Munro, 1984).

Results

A total of 255 samples were collected during the research. The ages of total examined fish ranged from 0 to 5 years,198 (77.6%) were males and 57 (22.4%) females (Fig. 2). Males were more numerous in the 0, 1 and 2 age groups, females in the 3 and 4 age groups. Maximum age was found to be 5 years for both sexes (Table 1). The overall sex ratio was 3.47:1 M : F and it was not statistically significant ($p>0.05$). The age-length key is given in Table 1. Males ranged from 10.7 to 31.0 cm with a mean of 19.65 (±0.19); females ranged from 10.4 to 33.0 with a mean of 21.39 (±0.59). Mean weight of males and females was 84.09 (±2.81) and 122.17 (±9.34), respectively. At t-test there were no significant differences between sexes in overall total length and weight (Table 2).

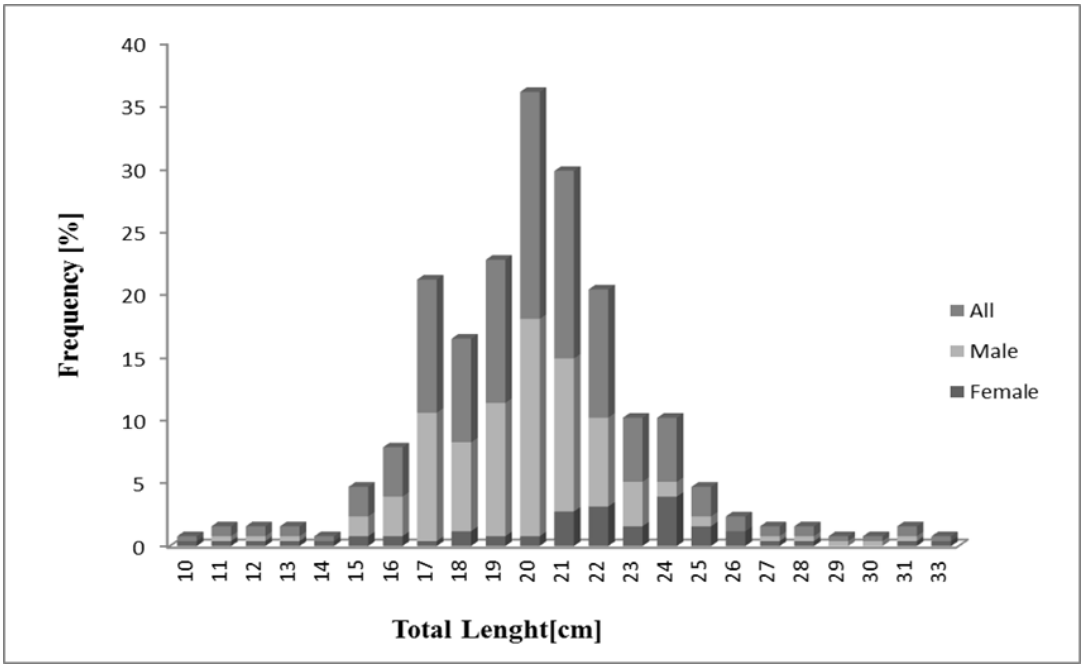

Figure 2: Length–frequency distribution of males, females, and both sexes of *Capoeta erhani* collected in the Seyhan River.

The length-weight relationship regressions calculated separately for males, females and both sexes were as following: log W= -5.184+ 3.213 log TL (r^2= 0.971, n=57) for females, log W= -4.906 + 3.114 log TL (r^2= 0.973, n=198) for males and log W= -5.067 + 3.168 log TL (r^2= 0.972, n=255) for both sexes combined (Fig. 3).

A comparison concerning the length-weight relationship for *C. erhani* was also made using the results achieved by previous studies (Table 3). von Bertalanffy growth equations were estimated as $L_t= 32.46[1-e^{-0.385t+0.834)}]$ for males, $L_t= 33.42[1-e^{-0.430t+0.913)}]$ for females and $L_t= 32.51[1-e^{-0.400(t+0.930)}]$ for both sexes. Munro's phi prime index in males, females and both sexes was calculated as 6.00, 6.12 and 6.04, respectively (Table 4). The mean lengths of the individuals of each age group were used to fit the von Bertalanffy growth model parameters, which is presented in Fig. 4. Females grew to a greater asymptotic length (L_∞) than the males, also the growth rate (k) was slightly higher in females than in males.

Table 1: Age-length key for males, females and all individuals based on scale readings from the Seyhan River.

Length intervals (cm)	Age groups (in years)						
	0	**1**	**2**	**3**	**4**	**5**	**Total**
10.5-11.4	3						3
11.5-12.4	11						11
12.5-13.4	3						3
13.5-14.4							0
14.5-15.4	6						6
15.5-16.4	1						1
16.5-17.4	6	21					27
17.5-18.4		21					21
18.5-19.4		26					26
19.5-20.4		14	20				34
20.5-21.4			15				15
21.5-22.4			22				22
22.5-23.4		3	20	2			25
23.5-24.4			23	10			33
24.5-25.4					1		1
25.5-26.4				12	1		13
26.5-27.4				3	1		4
27.5-28.4					2		2
28.5-29.4					4		4
29.5-30.4						2	2
30.5-31.4						1	1
31.5-32.4							0
32.5-33.4						1	1
Total	30	85	100	27	9	4	255
Mean TL ± SD	11.83 ±1.95	19.35 ±0.92	23.16 ±0.78	25.28 ±0.94	28.23 ±1.51	30.67 ±1.28	20.04 (3.25)
Mean TW ± SD	35.96 ±13.82	65.25 ±10.97	96.90 ±11.94	146.42 ±22.49	225.15 ±28.03	315.25 ±31.27	92.38 (50.52)
Males (% n)	21 (10.60)	79 (39.89)	83 (41.91)	11 (5.55)	2 (1.01)	2 (1.01)	198 (77.6)
Females (% n)	9 (15.78)	6 (10.52)	17 (29.82)	16 (28.02)	7 (12.28)	2 (3.50)	57 (22.4)
F : M	1:2.33	1:13.16	1:4.88	1:0.68	1:0.28	1:1	1:3.74

Table 2: Descriptive statistics and total length (TL) (cm)-weight (W) (g) relationships for *Capoeta erhani* from the Seyhan River.

				$\log_{10}W = a + b \log_{10}TL$			
Sex	**n**	**TL_{min}-TL_{max} (TL_{mean}±SE)**	**W_{min}-W_{max} (W_{mean}±SE)**	**a**	**b±95%CI**	**r^2**	**Growth Type**
Male	198	10.7-31.0 (19.65±0.19)	11.0-312.0 (84.09 ±2.81)	0.0074	3.114 ±0.037	0.973	Positive allometric
Female	57	10.4-33.0 (21.39±0.59)	9.0-360.0 (121.17±9.34)	0.0056	3.213 ±0.075	0.971	Positive allometric
Both	255	10.4-33.0 (20.04±0.20)	9.0-360.0 (92.38±3.16)	0.0063	3.168 ±0.033	0.972	Positive allometric

n: sample size; TL, total length (cm); W, weight (g); SE: standard error, CI: confidence interval, a: intercept, b: slope and r^2: coefficient of determination of the TL-W relationship.

Table 3: Comparisons of length-weight relationship parameters for *Capoeta erhani* from different environments

References	**n**	**Sex**	**Length type**	**L_{min}-L_{max} (cm)**	**a**	**b**	**r^2**	**Locality**
Turan *et al.* (2008)	1	M	SL	28.0	*	*	*	Ceyhan River
Ayyıldız *et al.* (2014)	75	M	TL	15.0-32.0	0.0054	3.20	0.975	Menzelet Reservoir
	60	F	TL	15.2-33.8	0.0097	3.00	0.986	
	135	M+F	TL	15.0-33.8	0.0075	3.08	0.979	
Erguden (2015)	190	M+F	TL	16.0-27.8	0.0049	3.27	0.951	Seyhan Reservoir

* No data in paper.

Table 4: von Bertalanffy growth parameters and equations of *Capoeta erhani* from the Seyhan River calculated in the present study.

Sex	**Growth parameters**				**Growth equations**
	L_∞(cm)	**k**	**t_0**	**φ´**	**$L_t = L_\infty [1-e^{-k(t-t_0)}]$**
Male	32.46	0.385	-0.834	6.005	$L_t = 32.46[1-e^{-0.385(t+0.834)}]$
Female	33.42	0.430	-0.913	6.122	$L_t = 33.42\ [1-e^{-0.430(t+0.913)}]$
Both	32.51	0.400	-0.930	6.046	$L_t = 32.51\ [1-e^{-0.400(t+0.930)}]$

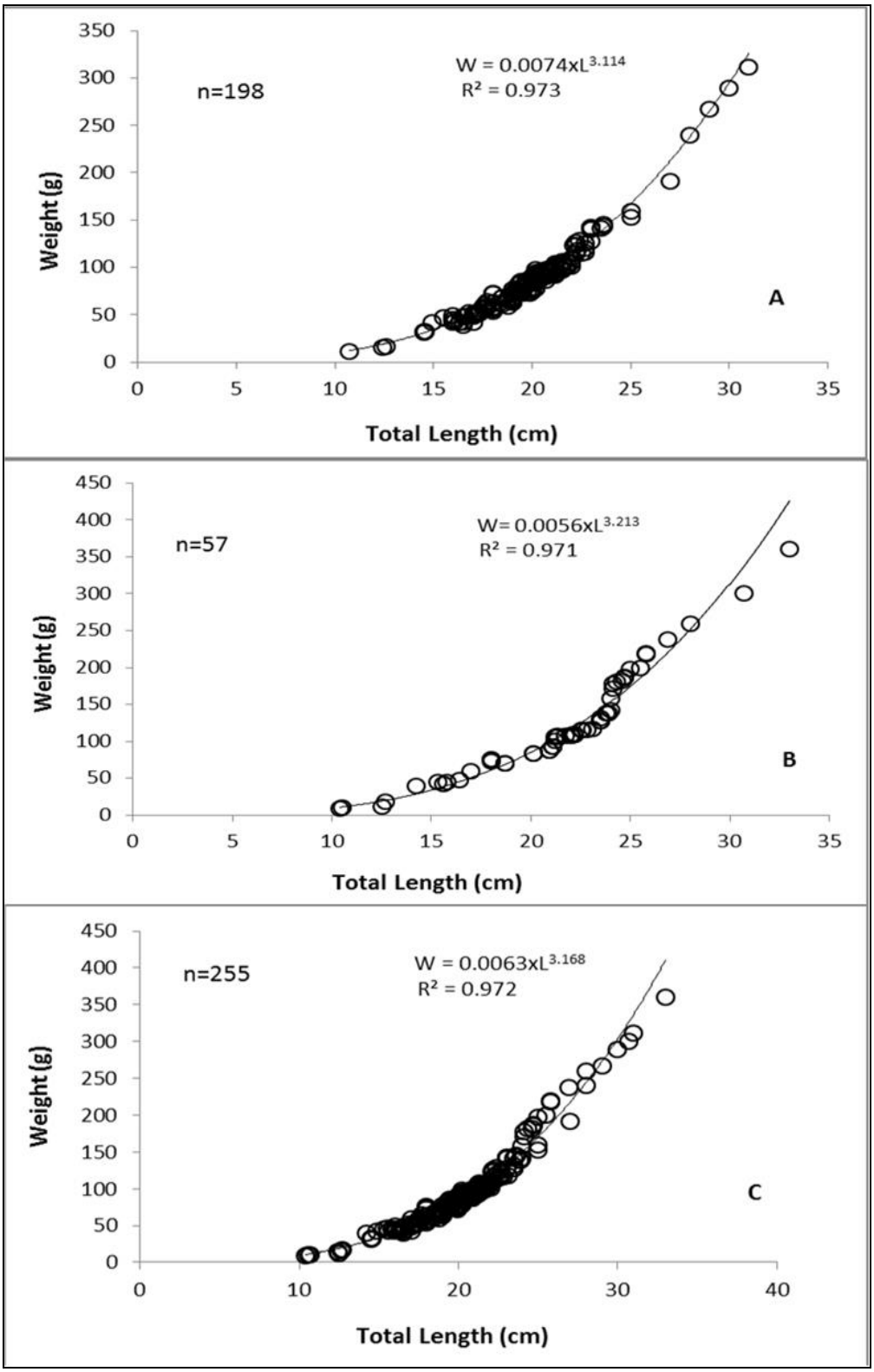

Figure 3: Length-weight relations combined sexes of *Capoeta erhani* from the Seyhan River A: males, B: females, C: both sexes.

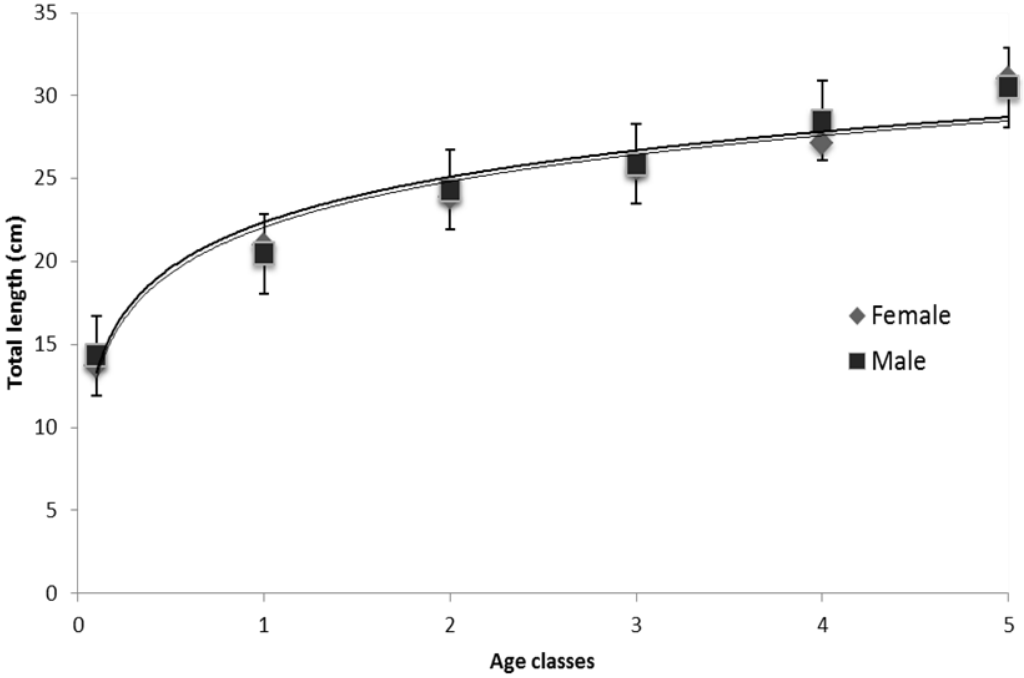

Figure 4: Growth of *Capoeta erhani* from the Seyhan River.

Discussion

Ceyhan scraper is endemic to a restricted area of Southeast Turkey and currently the data on population length structure of *C. erhani* is very limited. With regard to the study area the only information available is reporting of this species in the Seyhan Reservoir (Erguden Alagoz and Goksu, 2012; Erguden, 2015). In the present study, a maximum total length of 31.0 cm TL for males and 33.0 cm TL for females were determined. These observed lengths were slightly smaller than those reported by Ayyıldız *et al.* (2014) for the Menzelet Reservoir (32 for females and 33.8 cm TL for males), in line with those reported by Turan *et al*. (2008) for Ceyhan River (28 cm standard length), but longer than the maximum length found by Erguden *et al.* (2015) in Seyhan Reservoir (27.8 cm). According to Le Cren (1951) and Froese (2006) the length-weight relationships of fish are considerably related to season and affected by some factors such as stress, reproductive activity, environment and nutrition. Moreover, it is well known that individuals in populations exposed to high levels of fishery pressure reach relatively smaller lengths (Emiroglu *et al*., 2012).

Since *C. erhani* is consumed by local people, these differences could be due not only to ecological and biological factors but also to the fishery pressure carried on by local anglers and to the different mesh sizes of nets used. Further researches focusing on the size

selectivity of nets are strongly encouraged to clarify this aspect. *C. erhani* population of Seyhan River was composed of 77.6% males and 22.4% females. Also Ayyıldız *et al*. (2014) reported a sex ratio tilted in favour of males (1:1.25 F:M) for this species even if it was not so apparent as for our study. These differences in the sex ratio could be due to differences in the number of specimens examined, as well as to the area and seasonal effects. The overall sex ratio, indeed, may vary from species to species and may also change from year to year within the same population (Nikolsky, 1963). More specifically, in the present study the sex ratio varied within the age classes; in the younger age-classes it was heavily tilted in favour of males while among older the females became numerous. This finding was in line with Nikolsky (1963) reporting that generally, the ratio of males to females is higher in the early stages of life, while at later stages the situation is reversed. A similar sex ratio in favour of males in the early stages was also reported for other *Capoeta* sp. populations (Özdemir, 1982; Şen, 1988; Ünlü, 1991; Ekmekçi, 1996). The maximum observed age for *C. erhani* in this study was 5 years for male and female individuals of 31.0 and 33.0 cm, whereas Ayyıldız *et al*. (2014) found a maximum age of 6 years for males and females of 32.0 and 33.8 cm, respectively. The differences between estimates could be probably for the result of differences in the region sampled or within the different population, but can be also being attributed to the different methodology used to determinate age (scales versus otoliths).

The b value for the length-weight relationship in the fish population, indicating the type of growth in fish, has been shown to range from 2.5 to 3.5 (Froese, 2006). In this study, the exponent (b) indicated a positive allometric growth for *C. erhani* both for males (3.114) and females (3.207) (Table 3). These values were also in line with those of Ayyıldız *et al*. (2014) in Menzelet Reservoir, (3.015 for females and 3.201 for males) and Erguden (2015) in Seyhan Reservoir (3.270 for the total sample) (Table 3).

The von Bertalanffy growth functions calculated for both sexes of *C. erhani* in this study showed that, female theoretical maximal length value were slightly higher than the males. Similar estimated growth parameters were reported by Ayyıldız *et al*. (2014) for *C. erhani* from Menzelet Rezervoir (Table 5). The values of growth constant (k) obtained from this study were close to the values estimated for *C. c. capoeta* from the Gorganrud River, Iran (Abdoli *et al*., 2008) and *C. bergamae* from Kemer Reservoir, Turkey (Ozcan and Balik, 2009). However, these results are not similar to those reported for the same species from the Menzelet Reservoir (Ayyıldız *et al*., 2014) or by Alp *et al.* (2005) from the Ceyhan River (reported as *C. angorae*) (Table 5).

Table 5: Comparisons of growth performance of *Capoeta* species from different areas.

References	Species	Sex	Age	L_∞	k	t_0	Locality
Erdogan (1988)	*C. c. capoeta*	M	1-11	44.30	0.116	-1.210	Aras River
		F	1-11	48.30	0.111	-0.790	
Seifi (1990)	*C. c. capoeta*	M+F	2-4	22.00	0.389	*	Talar River
Skandari (1998)	*C. c. capoeta*	M	0-10	22.96	0.540	*	Madarso stream
		F	0-10	32.79	0.180	*	
Sasi and Balik (2003)	*C. angorae*	M	2-6	34.10	0.358	-0.340	Topcam Reservoir
		F	2-6	43.50	0.195	-0.190	
		M+F		40.00	0.238	-0.120	
Turkmen *et al*. (2002)	*C. c. umbla*	M	1-10	42.30	0.146	-0.980	Karasu River
		F	1-12	45.70	0.139	-0.830	
Alp *et al*. (2005)	*C. c. angorae*	M	1-7	47.25	0.133	-0.760	Ceyhan River
		F	1-10	62.25	0.101	-0.590	
Elp and Karabatak (2007)	*C. capoeta*	M+F	1-6	58.20	0.152	-0.380	Kockopru Reservoir
Abdoli *et al*. (2008)	*C. c. capoeta*	M	0-3	19.00	0.462	-1.000	Gorganrud River, south Caspian River
		F	0-3	23.00	0.472	-0740	
Kalkan (2008)	*C. trutta*	M	0-7	76.40	0.060	-2.650	Karakaya Reservoir
		F	1-7	89.50	0.057	-2.410	
Elp and Şen (2009)	*C. capoeta*	M	1-6	40.49	0.177	-0.907	Karasu stream
		F	1-6	54.65	0.130	-0.718	
		M+F	1-6	52.58	0.145	-0.464	
Ozcan and Balık (2009)	*C. bergamae*	M	1-4	25.00	0.344	-0.930	Kemer Reservoir
		F	1-4	27.20	0.308	-0.920	
		M+F	1-4	27.70	0.277	-1.110	
Emre *et al.* (2014)	*C. angorae*	M	0-5	22.84	0.772	-0.530	Menzelet Reservoir and Stream
		F	0-5	27.55	0.465	-0.710	
		M+F	0-5	42.25	0.102	-2.620	
Ayyıldız *et al*. (2014)	*C. erhani*	M	0-6	32.02	0.843	-0.570	Menzelet Reservoir
		F	0-6	33.83	0.964	-0.560	
		M+F	0-6	33.85	0.821	-0.480	
Present Study	*C. erhani*	M	0-5	32.46	0.385	-0.834	Seyhan River
		F	0-5	33.42	0.430	-0.913	
		M+F	0-5	32.51	0.400	-0.930	

* No data in paper.

It is clear that the differences between growth can be attributed to different environmental characteristics (such as food availability, hydrographical and climatic conditions). More specifically *C. erhani* in Seyhan River seems to grow slowly than in Menzelet Reservoir but faster than in Ceyhan River. This can be due to the differences in the habitats since it is well known that the growth rates wherein populations inhabit reservoirs are faster than those in rivers (Kwak *et al*., 2006). Also, fish populations of the same species from different geographical regions may exhibit highly variable individual growth rates (Wotton, 1990). However, it cannot be excluded that the population structure could be affected by local fishing. Similarly, reduced growth rates have also been reported for *Esox lucius*, *Scardinius erythrophthalmus* (Emiroğlu *et al*., 2010) and *Blicca bjoerkna* (Şaşı and Berber, 2012) from Lake Uluabat due to high exploitation. More information on the local fish effort of the Seyhan River is essential to clarify this aspect.

In conclusion, this study represents the first detailed observations on biological properties of *C. erhani* population inhabiting the middle basin of the Seyhan River. These results, together with further information on reproductive biology represent a useful background for future studies and monitoring on stock assessment and management of the species. Although the species is considered as not threatened, a continuous monitoring and the collection of data on different populations are strongly suggested to investigate the population trend of this endemic species still less studied.

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